City of Memphis
Maynard C. Stiles Wastewater Treatment Plant
Disinfection Improvements

Pilot Study Phase 3 Summary
February 15, 2015

Background

The objective of the full-scale peracetic acid (PAA) pilot study is to identify the best disinfection control strategy to achieve compliance with the future NPDES permit disinfection limits under varying flows and influent quality conditions. The Pilot Study Work Plan, previously developed and approved in 2014, includes a description of Dose Control Strategy, Phases of Testing, Data Analysis, Pilot Study Management, and Additional Industrial User Testing to be conducted.

The pilot is being conducted in phases; the first four include development of information on the best means of providing dose control. A fifth phase will be used to demonstrate efficacy of the final process control algorithm. Data collected during the pilot will be used to inform the final design of the dose control for the full-scale system design. This document provides a summary of the results of Phase 3.

Phase 3: Implementation

The wastewater from the north and south sides of the plant meet and discharge into the mixing compartment at the head of the contact tank. The combined flow is split into two parallel, serpentine contact channels. Pre-disinfection water quality, including color, chemical oxygen demand (COD), and undisinfected *E. coli*, is assessed at the head of the disinfection channel that is not receiving PAA. The water quality parameters are being measured continuously on-line, during this phase are as follows:

- Color - ChemScan UV-3151 series flow-thru sensor
- COD - YSI CarboVis 701 submersible probe

PAA residuals were measured throughout the disinfection channel by three separate, Ducotest Amperometric PAA sensors, P1, P2 and P3, as shown in Figure 1. Bacterial samples were also collected at several locations throughout the basin during testing, with locations also shown in Figure 1.

Using data from Phase 1, COD was selected as the water quality parameter for the feed forward control strategy based on the quality of fit between PAA demand and wastewater COD. The PAA dose during Phase 3 was determined by selecting a base PAA setpoint dose and adding additional PAA that is equivalent to the calculated demand from the wastewater characteristics, as shown in Equation 1. Here, the PAA demand is calculated as a function of COD, as determined during Phase 1.

$$PAA_{dose} = PAA_{setpoint} + PAA_{demand} \qquad \textbf{Equation 1}$$

During Phase 3, COD was continuously monitored as described above, and the chemical feed pump PLC calculates PAA demand from the measured COD; this value is added to the initial setpoint to pace chemical feed. During the ten days of Phase 3, two different $PAA_{setpoint}$ values were tested; the initial $PAA_{setpoint}$ value was decreased by one third of the initial dose setpoint halfway through Phase 3.

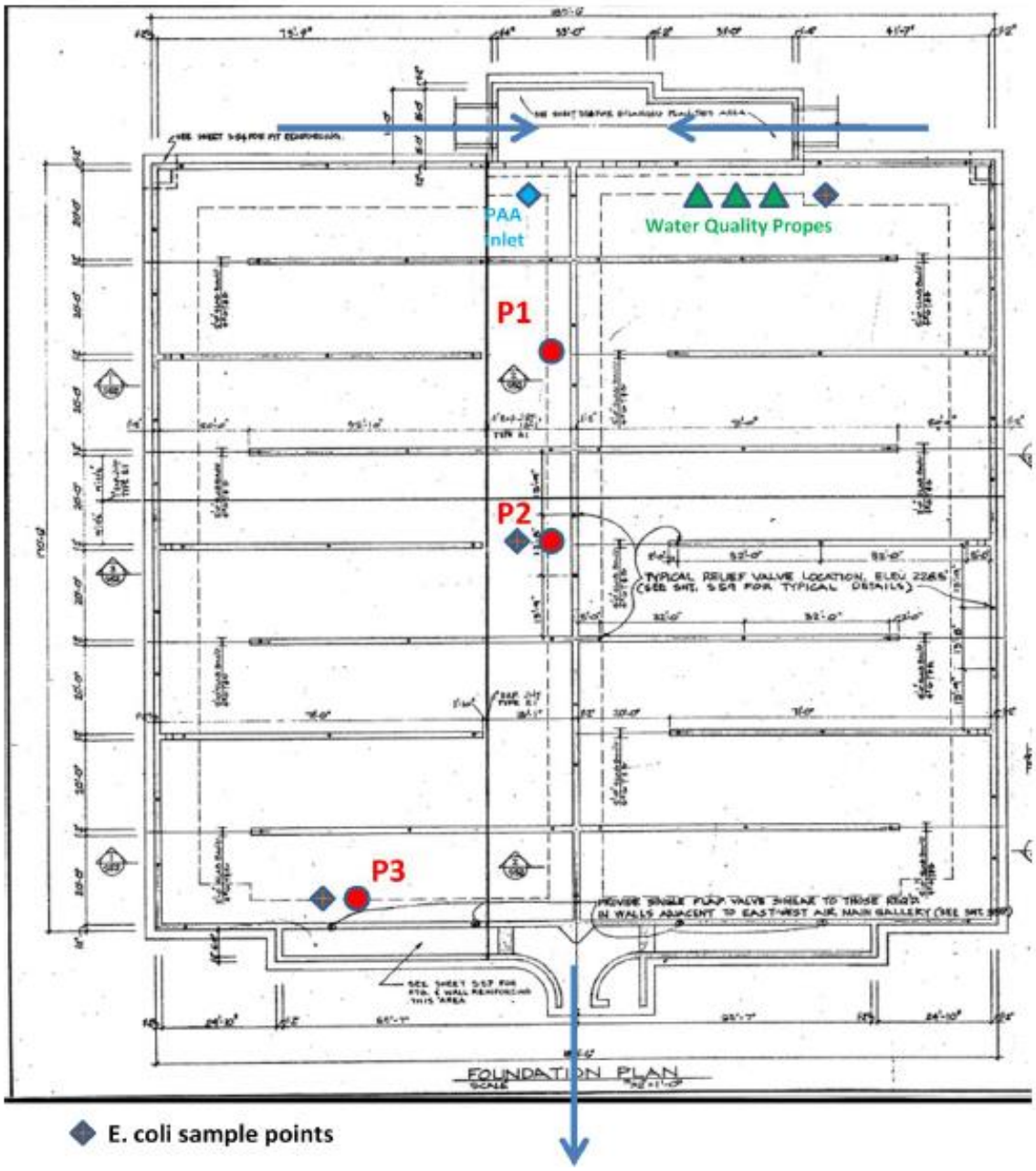

Figure 1. Water quality monitoring and sampling locations in disinfection contact tank.

Phase 3: Results

Phase 3 was initiated on January 19, 2015 and concluded on January 28, 2015. Data for PAA dose was plotted along with effluent COD, and PAA residual measured at Probe 1, and is provided in Figure 2. The PAA residuals at P2 and P3 were near the detection limit of the analyzer throughout the phase and are not shown; as a result, the analysis of Phase 3 data is based on the residuals reported at P1, which are shown in Figure 3 along with *E. coli* results.

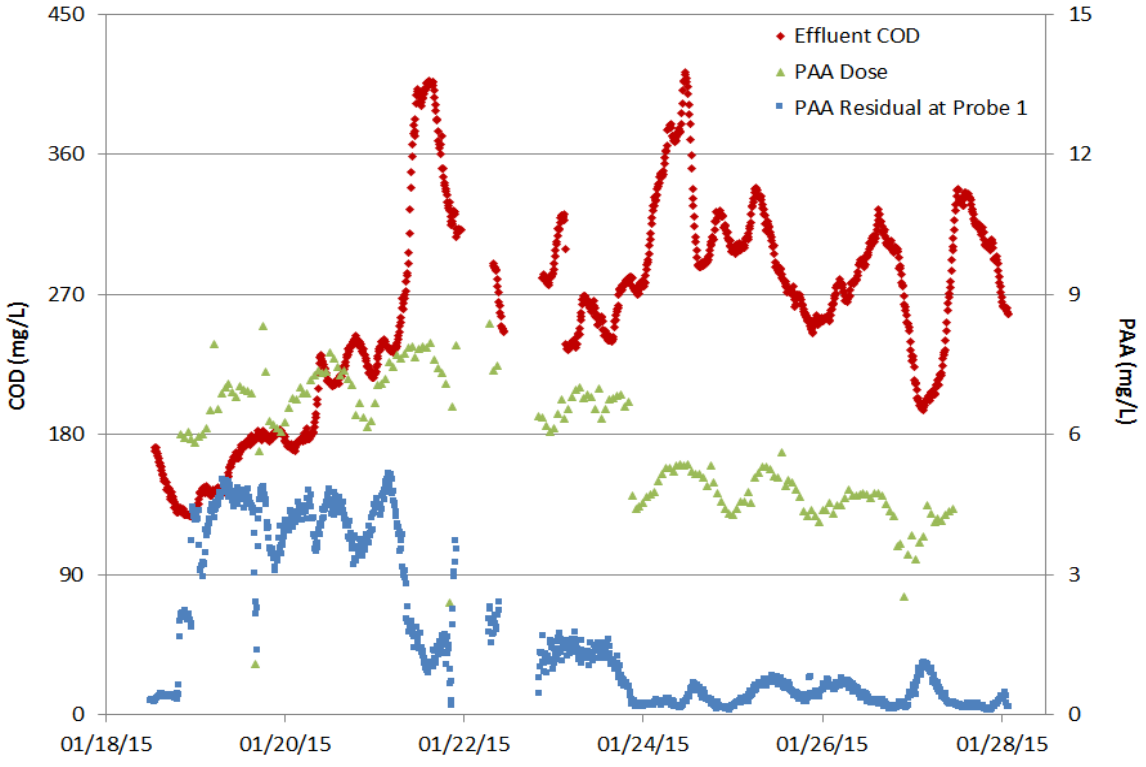

Figure 2. COD and PAA residual measurements during Phase 3.

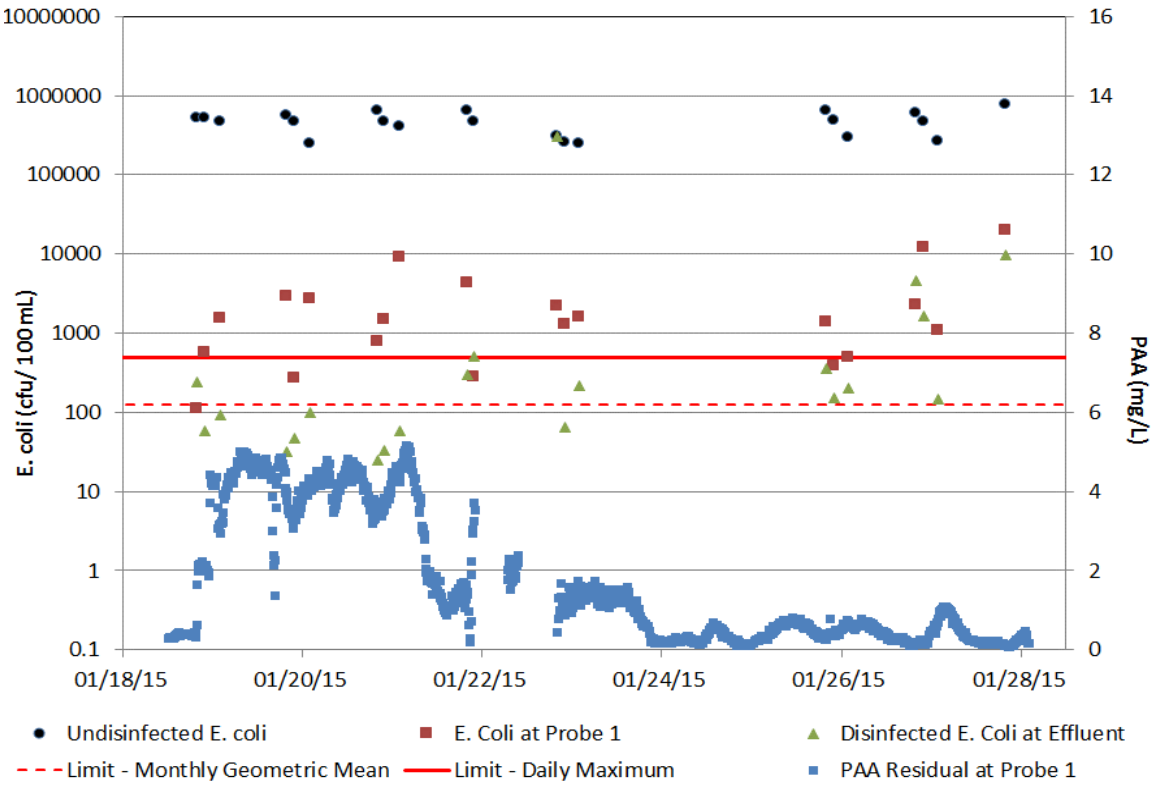

Figure 3. *E. coli* results and PAA residual measurements at Probe 1 during Phase 3.

There were two disruptions in the data collection during Phase 3. The first occurred during the period from January 22, 2015 at 8:20 am to 6:30 pm when the PLC control went inoperative due to a spurious signal being sent to the control algorithm; this programming issue was corrected and will not occur again. The second disruption occurred during a loss of power to the plant from January 22, 2015 at 9:40 pm to January 23, 2015 at 7:30 am. The loss of plant power caused a fault in the PAA dosing pump, which required a manual restart which did not occur until the morning of January 23rd. Both disruptions caused a loss in monitoring data and a disruption of PAA addition to the disinfection channel. While reducing the overall amount of data for analysis, it is not believed that this loss of data significantly impacts the conclusions drawn from the Phase 3 study. Considering the design implications that may be gained from the trial, the loss of PAA addition to the disinfection channel, resulting in loss of microbial control during the power outage and should be taken into consideration during full scale implementation (for example, this system should be designed with an uninterruptable power supply that is adequate until power can be restored to the system).

Results of the bacteria testing showed that COD was an adequate feed forward parameter for managing disinfection process control. Phase 3 was completed on January 28, 2015. The final E. coli results are shown below. With the initial PAA setpoint, in general, the effluent *E. coli* concentrations met the 126 cfu/100 mL criteria. The exceptions to this include the first *E. coli* value at the beginning of Phase 3, and can be attributed to the fact that the contact channel had not equilibrated with PAA at the time of the sample collection. In addition, *E. coli* values above the treatment target were also observed during the times when PAA addition was disrupted due to the PLC error and the power outage. Finally, when the PAA setpoint dose was lowered during the second half of Phase 3, *E. coli* concentrations generally did not meet the disinfection criteria, indicating that a higher setpoint that was used in this half of the study is needed to meet disinfection compliance.

Summary and Future Testing

Based on the results of this Phase of testing, as anticipated from data collected during Phase 1, COD could be correlated to disinfection performance. Additionally, this parameter which was used as the feed forward parameter for Phase 3 of testing provided to be an adequate process control parameter for managing disinfection.

The next phase of testing (Phase 4) will be conducted based on color as the feed forward parameter because color has proved to provide more precise dose control than COD. During Phase 4, which will be run for one month, data from Phases 2 and 3 will be used to refine the dose control model calibration by adjusting coefficients of the control algorithm and definition of process control set points.